

Seed-layer Effects on the Ferroelectric Properties of $\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$ Thin Films

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Abstract

Hafnium zirconium oxide ($\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$) exhibits properties that are significantly influenced by its composition ratio. Its exceptional ferroelectric properties make it suitable for use in non-volatile memory applications. The outstanding characteristics of HZO—high dielectric constant, low loss, and ferroelectricity, render it a critical material for next-generation semiconductor devices.

This study aims to enhance the ferroelectric properties of HZO, including the polarization-voltage (P-V) characteristics, capacitance-voltage (C-V) characteristics, endurance, and switching efficiency. Since the crystal structure predominantly controls ferroelectric properties, the research focuses on achieving the preferred orientation in HZO films by modifying the seed layer of the initial substrate stack. This approach seeks to control the crystal structure and improve ferroelectric properties.

To achieve this, the study compares different seed layers (TiN/TiO₂) and examines the impact of varying the seed layer thickness on ferroelectric performance. The ferroelectric characteristics are measured, and X-ray diffraction (XRD) techniques, including 2D-XRD and GI-XRD, are employed to observe the crystal structure and determine whether the preferred orientation occurs and how it enhances ferroelectric properties. The measurement results show that using a TiN seed layer can deposit HZO films with a preferred orientation. We also determined the impact of different preparation conditions on the crystal structure orientation of HZO films by changing the bottom interface layer with HZO.

Keywords - $\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$ (HZO), preferred orientation, ferroelectric, seed-layer